CHAPTER 1

Introduction

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Overview

The Greater Everglades ecological system, extending south of Lake Okeechobee in South Florida (**Figure 1-1**), provides habitat for a unique and diverse variety of animal and plant life. It also contributes to South Florida's water supply, flood control, and recreation. Historically, the Everglades was a free-flowing “river of grass” that provided clean water from Lake Okeechobee to Florida Bay (Douglas 1947). Overflow from the lake flowed south as sheet flow, over very wide and flat landscapes characterized in part by the microtopographic and vegetation features (**Figure 1-2**) that supported this unique ecological system.

Anthropogenic activities (including drainage, urbanization, and agriculture) have reduced the size and biodiversity of the Everglades ecosystem. They have also altered its hydrology. The result has been a reduced and degraded habitat for a wide variety of plant and animal life. Some species of plant and animal life are in danger of becoming extinct.

In an attempt to reverse the loss of this unique ecosystem, the Florida Legislature enacted the Everglades Forever Act (Section 373.4922, Florida Statutes). This act allocates funds to restore the Everglades “…both in terms of water quality and water quantity … in a manner that is long term and comprehensive.” More recently, Congress approved the Comprehensive Everglades Restoration Plan (CERP) in the Water Resources and Development Act of 2000 (WRDA 2000) for restoring and protecting the South Florida ecosystem. This plan focuses on “getting the water right.” Getting the water right involves four fundamental attributes: its quantity, its quality, its timing, and its spatial distribution.

Getting the water right is really a surrogate for getting the water-dependent ecology right. This report describes an approach to estimating the impact of alternative water management policies on the ecosystem without specifically modeling the behavior of various species within the ecosystem. It is an intermediate approach, assessing system performance with a greater focus on the ecology than solely hydrology but at the same time recognizing it is less than a full-scale multispecies ecological simulation. It attempts to relate various hydrologic variables to the relative condition of the habitat for selected species and features of the ecosystem.

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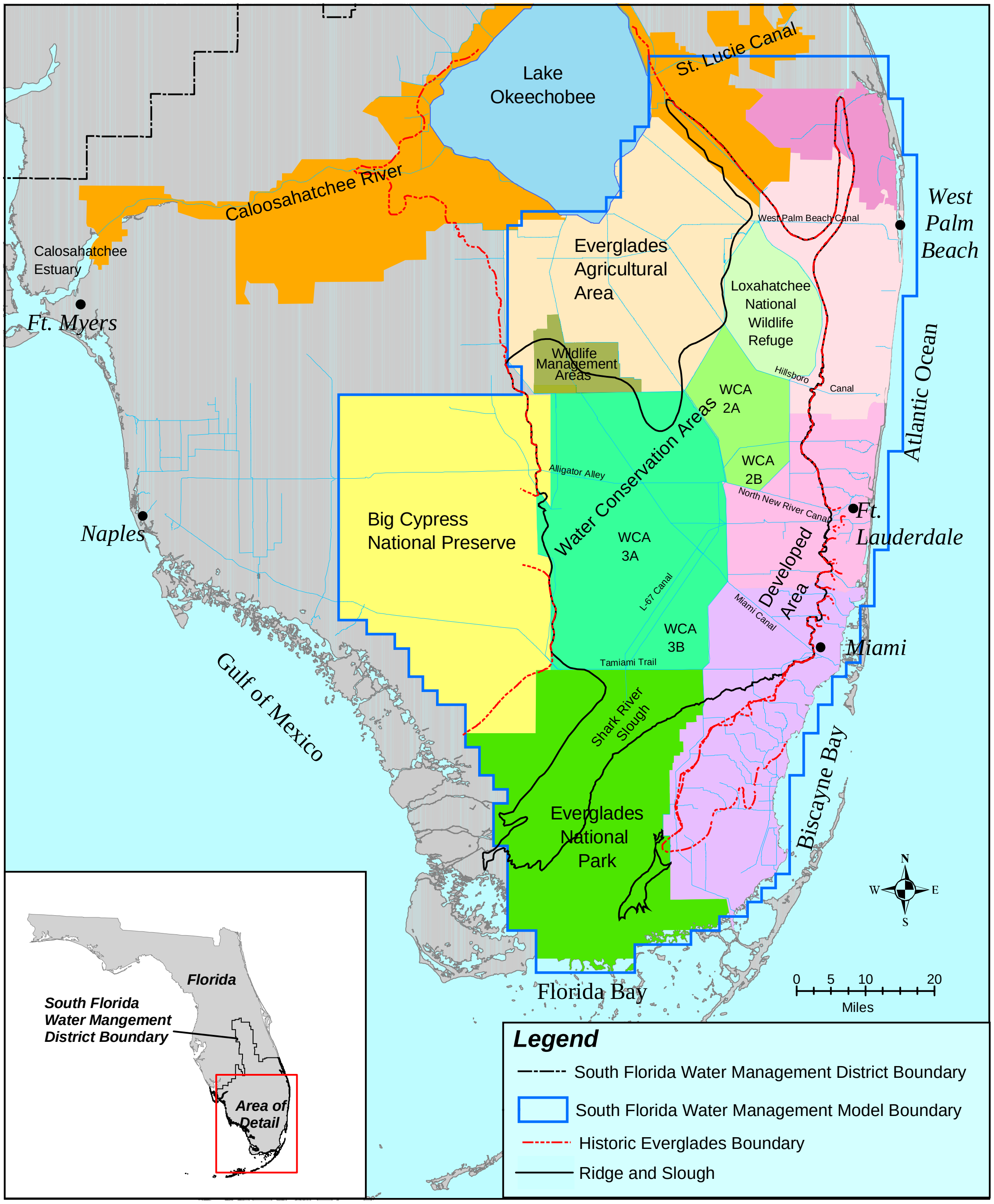

Figure 1-1. Greater Everglades region within which selected habitat suitability indices for evaluating water management alternatives are produced. Key features and geographical areas referred to later in this document are indicated in the figure.

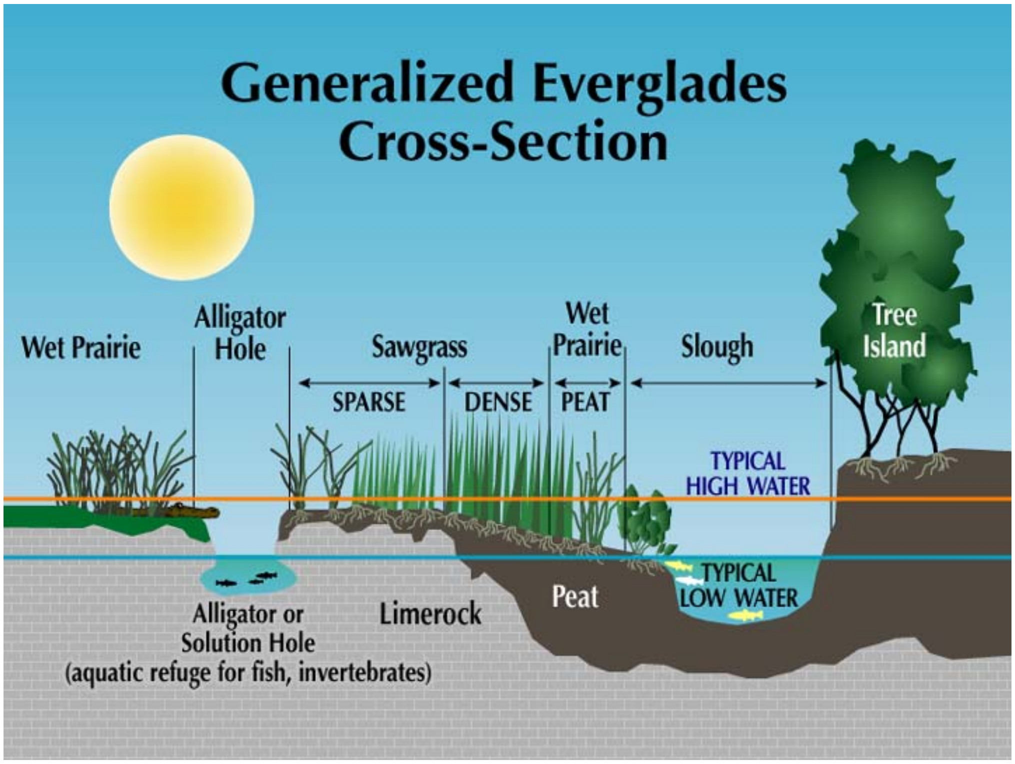

Figure 1-2. A characterization of a major portion of the Everglades in South Florida.

The remainder of this chapter provides more detail on the CERP and on how to move from “getting the water right” to “getting the habitat right” using water-dependent habitat suitability indices.

Comprehensive Everglades Restoration Plan

The Water Resource Development Acts of 1992 and 1996 (WRDA 1992, 1996) authorized the United States Army Corps of Engineers (USACE) to develop a comprehensive plan to restore and preserve the Everglades’ ecosystem, while also enhancing water supply and maintaining flood protection. The development of this plan was co-sponsored by the USACE and the South Florida Water Management District (SFWMD). A system-wide approach to managing the region’s water resources was adopted during the development of a comprehensive Everglades restoration plan by a team of ecologists, hydrologists, engineers, and other professionals from more than 30 federal, state, tribal, and local agencies. This effort was commonly called the Restudy. This comprehensive plan was published in the *Central and Southern Florida Project Comprehensive Review Study Final Integrated Feasibility Report and Programmatic Environmental Impact Statement* (USACE and SFWMD 1999). The Comprehensive Everglades Restoration Plan (CERP) was approved by Congress on December 11, 2000 (WRDA 2000).

The CERP provides the road map for restoring and protecting the South Florida ecosystem. This plan focuses on “getting the water right” by addressing four fundamental issues: the quantity, quality, timing, and distribution of water. Approximately 8 billion dollars, evenly divided between the state and federal governments, are planned to be spent on this restoration effort over the next several decades.

In summary, the CERP is to provide an integrated adaptive approach for restoring the ecosystem, for increasing the amount and reliability of water supplies, and for providing protection from flood damages (USACE and SFWMD 1999). The plan is seen as a vital step toward establishing a sustainable economy and ecosystem in South Florida. Three additional feasibility studies, Florida Bay and the Florida Keys, Southwest Florida, and a Comprehensive Integrated Water Quality Plan, will add information and details to enhance the restoration of the South Florida ecosystem.

Getting the Water Right

The current Everglades are only about half the size they were a century ago. While restoring their historic size is not feasible, the remaining Everglades ecosystem is to be restored by managing water in ways to reestablish historic (and hence assumed to be the most preferred) conditions. Proper water management is considered the key to ecosystem restoration in South Florida. Scientists, engineers, and other specialists working on the Restudy determined that the problems in the Everglades and the entire South Florida ecosystem were primarily the result of past water management practices and related development activities. Both the problems of declining ecosystem health and the solutions to Everglades' restoration have been framed by four interrelated factors: the quantity, quality, timing, and distribution of water. Water in the *right distribution*, at the *right time*, in the *right quantity* and *quality*, is considered a major determinant of ecosystem dynamics that support life in the Everglades.

Quantity

Significantly less water flows through the Everglades ecosystem today compared to a century ago. An average of about 1.7 billion gallons of water that once flowed through the ecosystem each year is currently discharged to the ocean or gulf. A key goal of the CERP is to capture most of this water in surface impoundments and underground aquifers, where it will be stored until it is needed. These storage facilities are needed to ensure a reliable, adequate supply of fresh water for the environment, as well as for urban and agricultural users. Of the “new” water captured by implementing the CERP, approximately 80 percent will to go to the environment and 20 percent will be used to enhance urban and agricultural water supplies.

Quality

The quality of water in the South Florida ecosystem has decreased significantly as agricultural and urban development has occurred. Excess phosphorus, mercury, and other constituents are now found in the region’s water. Similar signs of contamination are evident in the waters of the Everglades' water conservation areas, the coastal estuaries, Florida Bay, and the Florida Keys. Implementation of the CERP will improve the quality of water discharged to natural areas by first directing it to surface storage reservoirs and wetlands-based stormwater treatment areas. Further improvements in water quality will be needed to meet quality standards considered necessary for restoration of the original ecosystem character.

Timing

Seasonal fluctuations in water depths were vital to the historical functioning of the Everglades ecosystem. Human activities have tended to decrease average water depths, while at the same time increase the typical range or amplitude of seasonal depth fluctuations. Restoring natural variations in water flows and levels is an integral part of the CERP. An operational plan that mimics natural rainfall patterns will enhance the timing of water sent to the water conservation areas, Everglades National Park, and other wildlife management areas.

Distribution

The areal extent and movement of water through the system is the final factor in the water equation. Over 50 percent of the original Everglades have been lost to urban and agricultural development. That which remains has been separated, or compartmentalized, by canals and levees. To improve the connectivity of, and enhance sheet flow through, natural areas, more than 240 miles of levees and canals are to be removed within the Everglades. Some 20 miles of the Tamiami Trail (U.S. Route 41) are to be rebuilt with bridges and culverts, allowing water to flow more naturally south into Everglades National Park. In the Big Cypress National Preserve, the levee that separates the preserve from the Everglades is to be removed to restore more natural overland water flow.

Plan Cost - Hydrology - Ecology Trade-off

Implementing all these engineering projects to get the water right will be expensive. The estimated 7.8 billion dollars (in 1999 dollars) needed to implement the CERP will be spent over many years and will be shared by the federal government and the State of Florida. Once, and if fully, implemented, over 180 million in current dollars will be needed each year to operate, maintain, and monitor the CERP, especially if predrainage hydroperiods and water quality concentrations are to be achieved.

Can anyone be sure that the political will to continue with this effort will be sustained at this level of expenditure on into the coming decades, let alone the coming century? What if for any economic or other reason (e.g., defense spending or nation building) the hydrologic targets with respect to quantity, quality, timing, and location cannot quite be met? Or being optimistic, what if there is more money to spend? What ecological impacts might result from various deviations from preselected hydrologic targets? To address these questions, one needs to link the four components of hydrology directly to ecology, for it is ecology, not hydrology, that is of primary concern. One step towards directly achieving the ecological restoration objective is to get the ecological habitat right, at least for a variety of important indicator species and features of the ecosystem.

From “Getting the Water Right” to “Getting the Habitat Right”

Getting the ecological habitat right is only a first step on the way to being able to model and predict ecological responses to water management policies. Several ecological models for the Everglades have been under development for some years. This very challenging work continues. The step of linking habitat suitability indices to hydrology, described herein, is in no way a substitute for the more fundamental effort to continue developing ecological models for the Everglades. In fact, the identification of habitat suitability indices has been facilitated by these efforts to develop more comprehensive ecosystem models. Sklar et al. (2001) provides an excellent review of these models.

Getting the water right is part of a larger effort to restore the ecosystem to a sustainable healthy state. Considerable effort has been spent on developing conceptual ecological models defining the chain of cause-and-effect events or linkages between water and land management actions and the impact on specific ecosystem species in specific regions within the Everglades (Ogden and Davis 1999, RECOVER 2003). These conceptual ecological models (for example **Figure 1-3**) are not quantitative, but nevertheless, help identify the links between hydrologic characteristics and the relative condition of particular indicator species or features of the ecosystem. In this study, conceptual ecological models were used to help define water-dependent habitat suitability indices for selected ecosystem indicator species and landscape features. These suitability

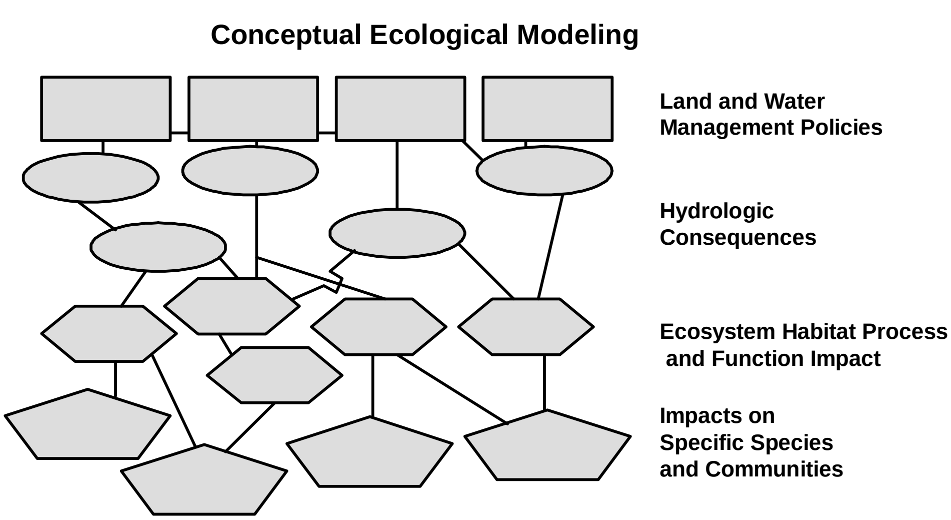

Figure 1-3. Schematic of a typical conceptual ecological model used to identify the important links between land and water management actions and ecosystem species response.

indices together with the hydrologic simulation models used in the development of the CERP provide estimates of the relative impact of alternative hydrologic regimes on various species' habitats and landscape features.

Habitat Suitability Indices

Habitat suitability indices have been used during the past two decades to define, in relative terms, the quality of the habitat for various wildlife species, especially fish. The United States Fish and Wildlife Service (USFWS) developed a series of habitat suitability index models to be used with habitat-based evaluation techniques, such as the Habitat Evaluation Procedures (HEP) (USFWS 1980) and the Instream Flow Incremental Methodology (IFIM). These techniques are designed for inventory, impact assessment, and the development of fish and wildlife management plans (see, for example, http://www.nwrc.gov/wdb/pub/hsi/hsiintro.htm).

Habitat suitability indices (USFWS 1981) can be used as a first approximation toward quantifying the relationships identified in the various conceptual ecological models (**Figure 1-3**). To illustrate the application of habitat suitability indices to the Everglades, we selected a number of important indicator species and landscape features for specific regions of the Everglades. The next step was to identify hydrologic variables that affect those species or landscape features. For this study, these key hydrologic variables were identified in a series of workshops attended by experts in the study of each particular species or landscape feature. The identified hydrologic variables are functions of the water quantity, quality, timing, and distribution; each of which can be modeled and managed in South Florida. Next, habitat suitability functions of these hydrologic variables were defined. These functions, ranging from 0 (least desirable) to 1 (optimum), indicate the relative condition of the indicator species or landscape features depending on the value of the hydrologic variables.

Once defined, these functions can be used to estimate the relative suitability of the resulting habitat for each indicator species or landscape feature over the relevant domain for application of the particular index or specific regions of interest associated with any specific simulated water management policy. The habitat suitability functions may change as new knowledge is obtained.

The purpose of this report is to describe the methods used to define these functions and show how they can be used to compare alternative water management plans or policies. The particular functions defined in this report merely illustrate the approach being used to evaluate alternative water management plans. *They do not necessarily define the specific habitat suitability functions that will be used in evaluating Everglades restoration plans. The specific habitat suitability indices to be used for evaluating alternatives during the implementation of the CERP will be defined after further study and review.*

Document Organization

The remainder of this document describes the steps taken to define the hydrologic variables and corresponding habitat suitability functions associated with several selected indicator species and landscape features in selected regions of the Everglades. The methodology used to identify key indicator species and the hydrologic simulation models that provide input to the habitat suitability index models are described in Chapter 2. The hydrologic (quantity) simulation models used in this study include the South Florida Water Management Model version 3.5 (SFWMM) and the Natural System Model version 4.5 (NSM).

Chapters 3 through 8 describe in more detail each specific habitat suitability index and its hydrologic variables. Initial results showing the relative performance of each index under simulated natural, current, and restored system hydrologic conditions are presented. These chapters are ordered starting from landscape (space-dependent) habitat suitability indices up the trophic chain to biotic (space/time-dependent) indices. Ridge and slough (Chapter 3), tree islands (Chapter 4), and periphyton (Chapter 5) are time-averaged, but spatially-variable habitat suitability indices. Fish (Chapter 6) and alligators (Chapter 7) are spatially- and temporally-variable indices. The suitability for wading birds (Chapter 8) varies in time and is not dependent on location as long as sufficient suitable habitat occurs somewhere within a relatively large area.

Comparisons between ecological indicators are presented in Chapter 9 to show how suitability indices can be used to highlight trade-offs between ecological indicators in comparing alternative water management strategies. Chapter 10 provides a synthesis of the linkages between the different habitat suitability indices within the context of the overall system. Finally, Chapter 11 presents some conclusions.

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WRDA. 2000. Water Resources Development Act of 2000. Public Law No. 106-541, signed December 11, 2000. Title VI, Section 601, of the act, describes authorizations specific to the Comprehensive Everglades Restoration Plan.